Work return with an intracardiac cardioverter defibrillator
Factors encouraging to return to work

- psycho-educational intervention
- exercise training to improve cardiopulmonary fitness
- correct misconception about the risk of many activities

and

information, information, information, education
Quality of the information provided: not so good?

161 pts in several implant centers

Suitable information had been given in \( \geq 70\% \) of patients in

**only 4 out of 13 items** (driving, antitheft porticos, mobile phone, MRI, microwave oven, induction cooker...)

Amara, congrès du CNCF 2012
What do patients understand?


METHODS:
Retrospective study carried out at 2 centers, pts are educated pre implantation.

RESULTS:
75 pts, 83% male, median age at time of implantation 64 years

median interval from implantation-to interview 3 years

Despite 83% claiming to understand the reason for ICD implantation

no patient suggested arrhythmia termination when describing the indication
Moreover:

50-65% believe their ICD:

- reduces risk of heart attack
- improves breathing, exercise capacity, and heart function

Despite preimplantation education:

- poor patient comprehension of the risks and benefits of ICD therapy
- patients' expectations of ICD therapy may be inappropriate

*education strategies before and after implantation require improvement*
Always have with you the **European device ID card**

Know what to do:
- shocks
- syncope
- alarm bell ringing

Be aware of the risk of certain electromagnetic interferences

Know the signs of local or general infection, especially in the post-implantation period and contact the doctor in the event of fever/suspected pocket infection/liquid collection
Living with an ICD can lead to mood disturbances with anxiety, fear of shock, and avoidance of situations, places and objects that the patient associates with shocks, like physical or sexual activity.

ICD patients reported more than 10-fold higher levels of phobic anxiety than a previous representative population survey.

The psychosocial distress created in patients and family members may be underappreciated by clinical care teams.

The disentanglement of cardiac disease and device-related concerns is difficult.

Phantom shocks were reported by 5.1% of ICD recipients with a median follow-up of 35 months.
Exercise training (ET) has a 1A recommendation in heart failure.

Results of 9 studies, comprising 1889 pts:

- Average duration of exercise-based cardiac rehabilitation (CR): 9.6 weeks
- 10 ICD therapies (seven shocks) in 834 patients with ICD during exercise
- 3 studies → the control group (sedentary patients) was more prone to ICD discharge than patients undergoing CR/ET
- In all studies the ICD patients improved their aerobic fitness following ET

=>” Based on the current literature, exercise in patients with an ICD is not associated with increased risk of shocks, improves aerobic capacity, while effects on anxiety, depression and quality of life are still under debate”
ICD and driving: License to kill drive?

1. AICD recipients have a little fewer accidents than the rest of the population.

1. A significant part of AICD recipients do not respect the recommendations.
By the August 31, 2010 French government decree modifying the December 21, 2005 previous decree

« light » group = A, B and E(B), E (C) and E(D) (non professional driving)

<table>
<thead>
<tr>
<th>ICD in secondary prevention</th>
<th>Driving permitted for 2 years according to the cardiologist recommendation, in the absence of syncope, faintness, provided appropriate follow-up is maintained</th>
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By the August 31, 2010 French government decree modifying the December 21, 2005 previous decree

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<td>After appropriate ICD therapy</td>
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<td>After replacement of the ICD</td>
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<td>After replacement of the lead system</td>
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<td>Patients refusing ICD for primary prevention</td>
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The return to work rate of ICD patients is influenced by the underlying cardiac disease and to a lesser extent by the implanted device

Rehabilitation of patients with (ICD) comprises: (1)

- pursuit of the treatment of the underlying cardiac disease
- an individually designed training program is acceptable at a level determined by both cardiopulmonary capacity and LV dysfunction, upper frequency limit, and the primary arrhythmic indication even on a high load level
- psychological education

(1) Relbis RK Dtsch Med Wochenschr. 2010

Reemployment following implantation of an automatic cardioverter defibrillator.
Special attention will be paid on potentially harmful situations:

- exposure to electromagnetic interferences
- excessive stress on lead systems and connections
Potential interference between ICD and electromagnetic fields is an important concern for physicians taking care of ICD recipients due to the risk of:

- temporarily suspension of the ICD function (magnet mode)
- oversensing leading to a false detection of ventricular arrhythmias

• Most of the sources of EMI have a low intensity and only a small number of these cause significant problems that need attention

• Furthermore, the exposure time is generally too short to result in unwarranted effects
### Electromagnetic Interferences

**At work**

- Mainly electric power companies (power generation and distribution)...
- Welding equipment or motor-generator systems
- Industrial induction or microwave oven
- Shield arc welding
- RFID (radiofrequency identification devices) specifically low frequency RFID
- Electrostatic discharge: no hazard
- Pilot (aircraft): prohibited
Electromagnetic interferences

At work

- In an individual, a specialist and an ICD manufacturer representative can assess in an electrically hostile workplace whether or not an EMI can occur and its clinical implications
- With the ultimate goal of allowing the patient to return to work
(1) Most patients employed before ACD implantation are able to return to work after the procedure.

(2) Nonmedical factors play an important role in the resumption of work-related activities.

(3) At follow-up, 29 patients (62%) had resumed work at 11 +/- 9 weeks after implantation. Multivariate analysis revealed that level of education was the single best predictor of reemployment status.

(4) These findings have important quality-of-life and cost-effectiveness implications for ACD implantees.
Reemployment following implantation of an automatic cardioverter defibrillator.

Finally

The patient:

• will be allowed to return to the or same or fitted job
• or to switch to another job
• or not to return to work

in agreement with
  occupational doctor
  cardiologist
  general practitioner
Electromagnetic interferences

Daily life

Hazard:
all electric domestic appliances if not earthed or in the presence of leakage current,
arc welding (....)
electric fence

No hazard:
well functioning domestic appliances
microwave and induction cooker
mobile phone (15 cm),
antitheft portico (pass without stopping)
airport security control (ID card to obtain security clearance)
local area network adapters (WLAN) (10 cm)
headphones (3 cm)
high voltage power line
high power mast
radars
Medical devices: MRI in theory contraindicated

- Kalin PACE 2005: « up to 75% of PM patients will require MRI within their lifetime »

- FDA: “for some patients, the risks presented by MRI under specific, characterized scanning and monitoring conditions may be acceptable given the diagnostic benefit of this powerful imaging modality”

- Nazarian: can be safely performed in selected patients according to indication, absence of an acceptable imaging alternative, appropriate settings of the AICD (magnet response and tachyarrhythmia functions disabled), device implantation < 6 weeks, radiologist and electrophysiologist present during all scans

- Hotly debated

- New MRI fully compatible AICD on the market..
The following precautions should be observed by the patient:
1) maintain a minimal distance of 2 ft (61 cm) from the welding arc and cables or large motors,
2) do not exceed tested currents with the welding equipment,
3) wear insulated gloves while operating electrical equipment,
4) verify that electrical equipment is properly grounded, and
5) stop welding and leave the work area immediately if a therapy is delivered or a feeling of lightheadedness is experienced.

Lehmann MH, It was concluded that (1) most patients employed before ACD implantation are able to return to work after the procedure, and (2) nonmedical factors play an important role in the resumption of work-related activities. These findings have important quality-of-life and cost-effectiveness implications for ACD implantees.
Inappropriate ICD discharge induced by electrical interference from a physio-therapeutic muscle stimulation device.

Nägele H, Azizi M.

Source
St. Adolfstift, Medical Clinic, Hamburger Str. 41, 21465, Reinbek, Germany.

Abstract
This report illustrates the case of a patient with an implantable cardioverter defibrillator (ICD) who during physiotherapy with transcutaneous electrical stimulation of the lumbar musculature perceived a shock discharge by the ICD. Analysis of the stored electrogram showed inappropriate therapy due to electromagnetic interference with the external stimulation. Patients as well as physiotherapists should be informed about this potential interaction to avoid such iatrogenic, inappropriate ICD therapy.
Intermittent, erratic behaviour of an implantable cardioverter defibrillator
Beinart Europace 2011

small magnets incorporated into the patient’s clothing
Know what to do

- **Single shock**, no chest pain, nor syncope or impaired dyspnea: call the implant center, the patient will be seen the same or the following day.

- At least 2 shocks, or syncope, chest pain, severe shortness of breath: same day control at the implant center.

- **Alarm bell ringing:**
  Control the same or the following day
  (may be due to battery depletion, high lead impedance, low R-wave amplitude, high pacing threshold, elevation of the thoracic impedance..)
Une épreuve d’effort récente, palier supérieur à 90 watts au moins 3 mn ou > 6 mets sans tdr ni ischémie, bon profil TA, autorise une reprise rapide dans la majorité des cas. MET = [(watts/kgx13)+3.5]/3.5

Intérêt des adaptations de poste: ex. port de lourdes charges, mesures individuelles de performance, réévaluation des contraintes de poste physiques et psychologiques

conduite automobile: si syncope, incompatibilité totale
A systematic literature review was carried out to study patient security and possible harmful effects, immunity and interferences on medical devices, and effectiveness and transmission problems in healthcare and hospital environments due to electromagnetic interferences. The objective was to determine already-reported cases of patient security, immunity of medical devices, and transmission/reception failure in order to evaluate safety and security of patients. Literature published in the last 10 years has been reviewed by searching in bibliographic databases, journals, and proceedings of conferences. Search strategies developed in electronic databases identified a total of 820 references, with 50 finally being included. The study reveals the existence of numerous publications on interferences in medical devices due to radiofrequency fields. However, literature on effectiveness, transmission problems and measurements of electromagnetic fields is limited. From the studies collected, it can be concluded that several cases of serious interferences in medical instruments have been reported. Measures of electromagnetic fields in healthcare environments have been also reported, concluding that special protective measures should be taken against electromagnetic interferences by incoming radio waves.
Soudure et moteurs et DAI

Electromagnetic interference from welding and motors on implantable cardioverter-defibrillators as tested in the electrically hostile work site. Fetter JG, Benditt DG, Stanton MS.
Source
Clinical Engineering Department, Medtronic, Inc. Minneapolis; Minnesota 55440, USA.
OBJECTIVES:
This study was designed to determine the susceptibility of an implanted cardioverter-defibrillator to electromagnetic interference in an electrically hostile work site environment, with the ultimate goal of allowing the patient to return to work.
BACKGROUND:
Normal operation of an implanted cardioverter-defibrillator depends on reliable sensing of the heart's electrical activity. Consequently, there is concern that external electromagnetic interference from external sources in the work place, especially welding equipment or motor-generator systems, may be sensed and produce inappropriate shocks or abnormal reed switch operation, temporarily suspending detection of ventricular tachycardia or ventricular fibrillation.
METHODS:
The effects of electromagnetic interference on the operation of one type of implantable cardioverter-defibrillator (Medtronic models 7217 and 7219) was measured by using internal event counter monitoring in 10 patients operating arc welders at up to 900 A or working near 200-hp motors and 1 patient close to a locomotive starter drawing up to 400 A.
RESULTS:
The electromagnetic interference produced two sources of potential interference on the sensing circuit or reed switch operation, respectively: 1) electrical fields with measured frequencies up to 50 MHz produced by the high currents during welding electrode activation, and 2) magnetic fields produced by the current in the welding electrode and cable. The defibrillator sensitivity was programmed to the highest (most sensitive) value: 0.15 mV (model 7219) or 0.3 mV (model 7217). The ventricular tachycardia and ventricular fibrillation therapies were temporarily turned off but the detection circuits left on.
CONCLUSIONS:
None of the implanted defibrillators tested were affected by oversensing of the electric field as verified by telemetry from the detection circuits. The magnetic field from 225-A welding current produced a flux density of 1.2 G; this density was not adequate to close the reed switch, which requires approximately 10 G. Our testing at the work site revealed no electrical interference with this type of defibrillator. Patients were allowed to return to work. The following precautions should be observed by the patient: 1) maintain a minimal distance of 2 ft (61 cm) from the welding arc and cables or large motors, 2) do not exceed tested currents with the welding equipment, 3) wear insulated gloves while operating electrical equipment, 4) verify that electrical equipment is properly grounded, and 5) stop welding and leave the work area immediately if a therapy is delivered or a feeling of lightheadedness is experienced.
OBJECTIVE:
The ICD is the gold standard therapy to prevent life-threatening arrhythmias. This study aimed to identify determinants and the course of phobic anxiety in ICD patients.

PATIENTS:
140 outpatients, mean age 56±14 years, 66% men.

MAIN OUTCOME MEASURES:
Phobic anxiety was assessed with the Symptom Checklist-90 Revised at a mean of 27±21 months post-ICD placement and after an average follow-up of 41±18 months. Multivariate linear regression models considered sociodemographic factors, clinical variables and psychological scales as potential determinants of phobic anxiety scores.

RESULTS:
ICD patients reported more than 10-fold higher levels of phobic anxiety than a previous representative population survey (2.6±3.4 vs 0.2±0.4).

Greater age (p=0.003), previous shock experience (p=0.007), depressed mood (p<0.001) and hypochondriasis (p=0.005) were associated with higher phobic anxiety scores at baseline.

CONCLUSIONS:
Phobic anxiety was comparably high and persisted over time in ICD patients. Modifiable determinants of phobic anxiety were identified, which may inform tailored interventions to improve ICD patients' distress and perhaps also prognosis.
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RESULTS:
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Reemployment following implantation of the automatic cardioverter defibrillator.

It was concluded that (1) most patients employed before ACD implantation are able to return to work after the procedure, and (2) nonmedical factors play an important role in the resumption of work-related activities. These findings have important quality-of-life and cost-effectiveness implications for ACD implantees.

However, the psychosocial distress created by the underlying arrhythmia and its potential treatments in patients and family members may be underappreciated by clinical care teams.

The disentanglement of cardiac disease and device-related concerns is difficult. The majority of ICD patients and families successfully adjust to the ICD, but optimal care pathways may require additional psychosocial attention to all ICD patients and particularly those experiencing psychosocial distress.

ICD + CHF patients had the most impaired physical health status but the lowest anxiety level followed by the ICD only and CHF only patients. Congestive heart failure only patients had the most impaired mental health status and reported the highest level of anxiety as compared to the ICD only (P < 0.001) and ICD + CHF groups (P = 0.009), while the two latter groups did not differ.
CLASSE I : PATHOLOGIE CARDIO-VASCULAIRE

Les affections pouvant exposer tout candidat ou conducteur, à la délivrance ou au renouvellement d'un permis de conduire, à une défaillance de son système cardiovasculaire de nature à provoquer une altération subite des fonctions cérébrales constituent un danger pour la sécurité routière.

La reprise de la conduite après tout événement cardiaque aigu et les renouvellements réguliers qui s'ensuivent imposent un avis et un suivi du médecin ou du spécialiste en charge du patient qui déterminera la périodicité des contrôles.

Les risques additionnels liés à la conduite du groupe lourd, notamment chez les conducteurs professionnels, seront envisagés avec la plus extrême prudence.

Les candidats ou conducteurs des catégories C, D, EC et ED relèvent des normes physiques requises pour le groupe lourd (groupe 2).

Il en est de même pour les candidats ou conducteurs de la catégorie B valable pour la conduite des taxis et des voitures de remise, des ambulances, des véhicules affectés à des opérations de ramassage scolaire ou des véhicules affectés au transport public des personnes, ainsi que les enseignants de la conduite (voir article 2).

<p>| 1.1 Coronaropathies | 1.1.1 : Syndrome coronaire aigu : infarctus aigu du myocarde et/ou angine de poitrine instable | La conduite sera reprise selon l'avis spécialisé. |
| | Compatibilité temporaire, sous réserve d'un suivi spécialisé régulier. |
| | Incompatibilité de tout syndrome coronarien non stabilisé. |
| | 1.1.2 : Coronaropathie asymptomatique et angine de poitrine stable | Compatibilité, après avis spécialisé. |
| | 1.1.3 : Angioplastie hors syndrome coronaire aigu | Compatibilité, après avis spécialisé. |</p>
<table>
<thead>
<tr>
<th>1.1.4 : Pontage coronaire</th>
<th>La conduite sera reprise selon l'avis spécialisé. Compatibilité temporaire après avis spécialisé et sous réserve d'un suivi spécialisé régulier.</th>
</tr>
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<tr>
<td>1.2.1 Tachycardie supraventriculaire paroxystique</td>
<td>Incompatibilité jusqu'au contrôle des symptômes. Compatibilité après avis spécialisé, et sous réserve d'un suivi médical régulier.</td>
</tr>
<tr>
<td>1.2.2 Fibrillation ou flutter auriculaire</td>
<td>Incompatibilité jusqu'au contrôle des symptômes. Compatibilité après avis spécialisé, et sous réserve d'un suivi médical régulier.</td>
</tr>
<tr>
<td>1.2.3 Extrasystoles ventriculaires</td>
<td>Compatibilité temporaire après avis spécialisé, puis selon l'évolution clinique, retour à la périodicité réglementaire des visites médicales</td>
</tr>
<tr>
<td>1.2.4 Tachycardie ventriculaire non soutenue sur cœur sain</td>
<td>Incompatibilité jusqu'au contrôle des symptômes. Compatibilité après avis spécialisé, et sous réserve d'un suivi médical régulier.</td>
</tr>
<tr>
<td>1.2.5 Tachycardie ventriculaire non soutenue sur cœur pathologique</td>
<td>Incompatibilité jusqu'à évaluation précise du risque par un spécialiste. Compatibilité temporaire après avis spécialisé, et sous réserve d'un suivi spécialisé semestriel.</td>
</tr>
<tr>
<td>1.2.6 Tachycardie ventriculaire soutenue ou fibrillation ventriculaire en rapport avec une cause aiguë et curable</td>
<td>Incompatibilité jusqu'au contrôle des symptômes. Compatibilité temporaire sur avis cardiological, sous réserve d'un suivi spécialisé semestriel.</td>
</tr>
<tr>
<td>1.2.7 Tachycardie ventriculaire soutenue ou fibrillation ventriculaire en rapport avec une cause chronique</td>
<td>Avis spécialisé obligatoire. Si confirmation de l'affection : incompatibilité</td>
</tr>
<tr>
<td>1.2.8 Défibrillateur automatique implantable en prévention secondaire</td>
<td>Avis spécialisé obligatoire. Si confirmation de l'affection : incompatibilité. (En cas de refus d'implantation par le patient, se reporter à l'affection justifiant l'indication.)</td>
</tr>
<tr>
<td>1.2.9 Défibrillateur automatique implantable en prévention primaire</td>
<td>Avis spécialisé obligatoire. Si confirmation de l'affection : incompatibilité. (En cas de refus d'implantation par le patient, se reporter à l'affection justifiant l'indication.)</td>
</tr>
<tr>
<td>1.2.10 Dysfonction sinusale et bloc auriculo-ventriculaire</td>
<td>Compatibilité temporaire si, après avis spécialisé, il n'y a pas d'indication à une stimulation cardiaque.</td>
</tr>
<tr>
<td>1.2.11. Pose de stimulateur cardiaque</td>
<td>La conduite sera reprise selon l'avis spécialisé. Compatibilité temporaire et sous réserve d'une surveillance spécialisé régulière.</td>
</tr>
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</table>
The recipient of implantable defibrillator must be fully and properly informed

- Should be trained to distinguish true arrhythmias from artifacts on the scope
- Should set detection off (using a magnet) when facing repeated shocks in a fully conscious patient and no evidence of tachycardia given by the ECG monitor
- Should know that in case of shock there is no risk for the doctor operating chest compression...

The emergency team too!
Electromagnetic interferences

Medical devices: